TESTING LOW HYDROSTATIC PRESSURE (LHP) TECHNOLOGY FOR APPLICATIONS OF INTEREST TO THE CALIFORNIA TREE FRUIT INDUSTRY

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FINAL COMMENTS

From this test, we concluded that low hydrostatic pressure (LHP) treatment of fresh peaches, nectarines, and plums is not a viable option as a fruit disinfestation alternative to methyl bromide due to the extensive damage to the fruit both immediately after treatment and after ripening.

ABSTRACT

The main goal of this project was to provide the tree fruit industry in California with a fruit disinfestation alternative that is acceptable to consumers, industry and regulatory agencies, equal to or more effective than current treatments (chemical, irradiation and hydrothermal technologies), meets consumer expectations and has minimum impact on fresh and dried fruit quality. The objective of this project was to examine the effect of LHP treatments on the quality of fresh peaches, nectarines, and plums. The proposed low hydrostatic pressure (LHP) technology effectiveness reflects independence from fruit size and geometry because pressure transmission into fruits is essentially instantaneous. Egg and larvae inactivation has been reported for short-time LHP applications.

Fresh fruit, a yellow flesh, clingstone nectarine, a white flesh, freestone peach and a dark plum were tested. LHP treatments tested were 20,000 and 30,000 psi (138 MPa and 207 Mpa) for 0, 1, 3, and 10 min. and controls (KAC, and to OSU and back to KAC). The treatments were carried out using a 22 liter high hydrostatic pressure vessel capable of reaching 85,000 psi (590 MPa or 5,800 atmospheres) located at the Oregon State University (OSU) Food Processing Pilot Plant. The treatments were applied to both naked and bagged fruit.

Fresh fruit visually evaluated after treatment showed various types of damage from all LHP treatment pressure-time combinations. Cracking of the skin on the peaches and nectarines, and pitting and tiny bumps on the plums were visible on naked and bagged fruit.

For the peaches, after 3 days of ripening, nearly all of the fruit from all of the LHP treatments were visually unacceptable showing external damage of cracked skin, discoloration and water soaked areas. Internal damage included water soaked flesh and brown pit cavity. For the nectarines, after 3 days of ripening, nearly all of the fruit from all of the LHP treatments were visually unacceptable showing external damage of cracked skin, discoloration, pitting and water soaked areas. Internal damage included water soaked flesh, brown flesh and brown pit cavity. For the plums, after 3 days of ripening, nearly all of the fruit from all of the LHP treatments were visually unacceptable showing external damage of leaking juice, hairline cracks, staining and pitting. Internal damage included translucent flesh, brown flesh and brown pit cavity.

From this test, we concluded that LHP treatment of fresh peaches, nectarines, and plums is not a viable option as a fruit disinfestation alternative due to the extensive damage to the fruit both immediately after treatment and after ripening.

INTRODUCTION

Chemical disinfestation treatments of fruits are not well accepted by consumers and regulatory agencies because they add potential residue risks to our diets and their use may have an environmental impact. For example, methyl bromide (MeBr), an odorless and colorless gas has been used as an agricultural fumigant to control a wide variety of pests. However, because MeBr depletes the stratospheric ozone layer, the amount of MeBr produced and imported in the U.S. was to be reduced until its January 1, 2005 phase-out. Exemptions from this phase-out decision include quarantine treatments when no technically or economically feasible alternative is available. In 2005, the available MeBr inventory in the USA reached a 40% reduction with respect to 2003 levels demonstrating the need to find an alternative for its use in fruit treatments.

A recently proposed alternative is the so-called metabolic stress disinfestation (Lagunas-Solar et al., 2006). Inside sealed chambers, fruits are subjected to alternating vacuum and pressurized carbon dioxide with ethanol gas applied briefly to further damage insect eggs. Unfortunately, effective and reproducible treatment applications require 2–3 h at room and 3–4 h at refrigeration temperature. In addition, the ability of the treatment to inactivate eggs and larvae will depend on the ability of carbon dioxide and ethanol gas to reach their location within the fruit.

A low hydrostatic pressure (LHP) technology has been proposed as a disinfestation alternative (Butz and Tauscher, 1995). Butz and Tauscher found no Mediterranean fruit fly (*Ceratitis capitata*) survivors when treated at pressures above 18,000 psi (125 MPa) and that inactivation at these pressures was independent of treatment time and temperature.

LHP offers short-time treatments (few minutes) and since pressure is almost instantaneously the same for the entire fruit, the treatment effectiveness should be the same independent of the egg and larvae location within the fruit. A further and critical advantage from a technology transfer point of view is LHP technology effectiveness independent from size and geometry factors for the fruit and the pressure vessel. Therefore, LHP conditions found to be effective using research pressure vessels for process demonstration purposes can be used commercially with minimum need for scale-up research. Finally, high pressure processing (HPP) units are an export opportunity that benefits the USA as it has become a world leader in this technology. Current worldwide HPP applications include pasteurization of juices, fresh cut fruits, sliced processed meats, beverages, oyster shucking, ready-to-eat dishes and many other foods. It should be noted that these HPP applications use ~ five times higher levels of hydrostatic pressure as the one needed for the proposed LHP disinfestation of fresh fruits. Thus, Hydrostatic Pressure Technology (LHP) is a novel non-thermal and non-chemical technology that needs to be tested for California crops.

OBJECTIVE

- Evaluate the quality of fresh peaches, nectarines, and plums subjected to LHP treatments immediately after treatment and after ripening.

PROCEDURES

Fruit samples were transported in a refrigerated vehicle to Corvallis, OR to use a 22 liter high hydrostatic pressure vessel capable of reaching 85,000 psi (590 MPa or 5,800 atmospheres) located at the Oregon State University Food Processing Pilot Plant (Fig. 1).

LHP treatments tested were: 20,000 and 30,000 psi (138 MPa and 207 MPa) for 0, 1, 3 and 10 min. Controls (untreated KAC, and untreated to OSU and back to KAC) and LHP-treated fruit were transported back to the Kearney Agricultural Center where fruit and quality was assessed after 3 days of ripening. A set of untreated fruit was left at KAC as a control for transportation. LHP treatments were conducted in a randomized manner and replicated three times to assess treatment variability.

For the fresh fruit, one peach (freestone, white flesh), one nectarine (clingstone, yellow flesh), and one plum (red color plum) were picked at CA well matureD. Four fruit per replication (experimental unit) were used. Bagged fruit were prepared as follows. The four fruit of an experimental unit were placed in a vacuum bag (Fig. 2). The air was evacuated and the bag was double sealed immediately before treatment using a Fuji Impulse Vacuum Sealer (Deerfield, IL).

Fresh fruit, both naked and bagged from the same treatment-rep were placed in the pressure vessel sample bag, the sample bag was filled with water and the air was squeezed out of the sample bag (Fig. 3). Next, the sample bag was lowered into the vessel on a hoist, the pressure vessel was sealed and the treatment was applied. Immediately after treatment, the tested fruit were removed from the sample bag, placed in labeled panta paks for immediate visual fruit quality evaluation and digital photographs and subsequent transport back to KAC for visual fruit quality evaluation after ripening.

RESULTS

Both naked and bagged fresh fruit, regardless of the LHP treatment pressure – time combination showed severe cracking of the skin on the peaches (Fig. 4) and nectarines (Fig. 5) and tiny bumps and pits on the skin of the plums (Fig. 6) immediately after treatment.

After ripening for 3 days, both the peaches and the nectarines exhibited external damage of skin cracking and pitting, skin discoloration and breakdown of the skin. Internal damage consisted of flesh browning and translucency (Fig. 7, 8).

After 3 days of ripening, the plums exhibited external damage of severe pitting of the skin, juice leakage through the skin, cracking of the skin and skin discoloration. Internal damage consisted of flesh browning and translucency (Fig. 9).

PRELIMINARY CONCLUSIONS

From this test, we concluded that LHP treatment, naked and vacuum sealed, of fresh peaches, nectarines, and plums is not a viable option as a fruit disinfestation alternative due to the extensive damage to the fruit both immediately after treatment and after ripening at the tested pressure – time combinations.

PROJECT STATUS

This was the first year of a one-year project.

REFERENCES

Butz, P., and B. Tauscher. 1995. Inactivation of fruit fly eggs by high pressure treatment. Journal of Food Processing & Preservation. 19(3): 161–164.

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Fig. 1. Twenty-two liter high hydrostatic pressure vessel.

Fig. 2. Filling pressure vessel sample bag with water.

Fig. 3. Fruit samples in vacuum sealed bags.

Fig. 4. Skin cracking on peaches immediately after pressure treatment.

Fig. 5. Skin cracking on nectarines immediately after pressure treatment.

Fig. 6. Pitting and bumps on plums immediately after pressure treatment.

Fig. 7. Flesh browning and translucency on pressure treated peaches after 3 days ripening.

Fig. 8. Flesh browning and translucency on pressure treated nectarines after 3 days ripening.

Fig. 9. Flesh browning and translucency on pressure treated plums after 3 days ripening.